Heretofore Unobserved Acoustic Signature of Thermoelectric Materials Responsible for Property of Continual Thermal Flux Resulting in Formation and Re-Establishment of Chemical Bonds as Well as Inter-Layer Torsional Effects, Leading to Piezo-Electric Effect - Novel Thermoelectric Material Design Concept Calls for Emphasis on Conditional Thermal Insulative Effects in Mediating Layers

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Introduction

Thermoelectric research stands at an impasse, largely as a result of a failure to understand what is actually driving the conversion of heat into electricity within known thermoelectric compounds. A novel insight into the inner workings of thermoelectric effects that recommends their re-categorization under the auspices of piezoelectric effects is suggestive of a novel approach to efficient thermoelectric materials design.

Abstract

A fundamental tenet of thermoelectric materials design to date is that materials must have a thermal gradient in which one side of a plate is "hot" and one is relatively "cold." In order for a piezoelectric effect to be realized, there must be a flux in pressure, torsion, or temperature (changes to temperature resulting in the expansion or contraction of metals and leading to torsion.) The fact that a thermoelectric compound can generate current whatsoever given a steady and uniform heating to only one side of a thermoelectric plate is remarkable given that a static thermal gradient should not generate current as the relative configuration of the material should not be in flux. While a static thermal distribution could, reasonably, lead to the generation of electricity through a heat-to-light followed by a separate light-to-electrical conversion step (inefficient,) thermoelectrics do not operate on such a basis. It is therefore reasonable to conclude that something else is at play in these materials.

Piezo-electric effects likely underpin what has heretofore been improperly categorized under the distinct auspices thermoelectric effects given that thermoelectric materials have a combination of both acoustic and structural properties that lend themselves to the generation of structured, internally circulated acoustic energy that is capable of creating recursive thermal ripples within seemingly thermally uniformed materials. As acoustic energy can be used to generate, negate, or transport heat (as in acoustic active cooling of microprocessors,) thermoelectric compounds may achieve their electrical-generative effects through a combination of the generation of minute amounts of acoustic energy in response to heating and a structure that causes this energy to be circulated in vortex-like patterns within the material, resulting in local instability in temperature and therefore perpetual expansion and contraction of the material. Whenever a molecular bond is broken or re-established, a small

amount of current is generated. Whenever the torsional interrelationships of the materials shift, current is continually generated. Only through the self-generation of shaped acoustic energy could thermoelectric compounds derive their property of continual electrical generation as only continual thermal (and therefore mechanical) flux of the material could generate continual current. This effect is not presently recognized by the physics/materials engineering community for reason that no one has taken the time to seek out evidence of such an effect.

Once this is understood, a novel approach based upon the incorporation of mediating layers composed of GaTe2 (silver anion impregnated tetrahedral configuration) or a similar nanostructure that is capable of conditional thermal insulation, the condition being the directional orientation of the insulating particle. AgGaTe2 or a similar material might, when incorporated in a mediating layer between two traditional thermoelectric layers, be bound to those layers through a molecule such as an additional pair of silver atoms or other concatenators through a weak chemical bond. When the tetrahedron is oriented lengthwise, it forms a complete bridge between the concatenator molecules that act as male adapters protruding from two distinct layers. When oriented lengthwise, AgGaTe2 is a perfect thermal insulator capable of permitting the flow of current as established at MIT in 2022.

When turned on its side, however, the thermal insulative effects may be reduced in this and in other comparable nanostructures. Thus, in such a scheme, a primary layer may be heated and the dissipation of heat from this material may be impeded by such a mediating layer connected to an adjacent layer. As the primary layer expands, torsional stress would be created between the layers culminating in the breaking of the bonds between the mediating conditional insulator as the primary layer would expand while the next successive layer would not. Upon the breaking of the bonds between the mediating insulator, substantial current would be generated and heat would begin flowing between the layers, causing the next layer to expand to match the expansion of the first layer. In so doing, the primary layer would contract while the secondary layer expands. Neighboring layers once again brought into a comparable state of expansion (and thus alignment,) the insulating molecules would spontaneously re-adhere to their concatenators, thus demarcating the outset of another cycle of thermal buildup in the primary layer and causing the secondary layer to begin to cool.

As these layers would be in constant thermal flux brought about by a shift in the insulative properties of the material, they would generate electricity with greater efficiency and at lower temperatures than existing thermoelectric compounds unaided by the proposed mediating layers.

Furthermore, the existing thermoelectric compounds may be redesigned now that the importance of acoustic thermal circulation may be accounted for in the design process. A multi-layered approach in which heat is allowed to build and dissipate every few seconds combined with tailored thermoelectrics which have

both the strong tendency toward acoustic generation when heated as well as a strong tendency toward channeling acoustic energy along curved pathways would be optimal for the application of the conversion of heat into electrical current.

Conclusion

Despite being overshadowed by advancements in both photovoltaic and fusion-based electrical generation, improved thermoelectric energy conversion may prove useful in certain areas such as industrial waste heat recycling.

Tantalizingly, if a sufficiently perfected design based upon the aforementioned principles were developed, it could be possible to generate meaningful amounts of current at around room temperature with such materials having a natural tendency toward maintaining sub-freezing temperatures in the absence of significant introduction of waste heat to the modules. This could eventually prove more practical than photovoltaic energy conversion given the ability to derive electrical energy from the perpetually 55-degree Fahrenheit crust of the Earth at all times of day, in all seasons and in any clime.

Such thermoelectric technology would not be subject to substantive wear as are photovoltaics. Homes of the future might be augmented by the installation of "thermoelectric spikes" that run hundreds of feet into the ground, directly generating current rather than being used merely to modestly heat or cool air via convector as has been demonstrated to date.